MECHANICAL LOCKING DEVICE FOR CONTACTORS, AND AUXILIARY TOOL THEREFOR

[0001] The present invention relates to a locking device for preventing two electromagnetically operable contactors forming a switch block from being simultaneously switched on, and to an auxiliary tool for making such a locking device, as defined in the preambles of the independent claims.

[0002] German Patent Application DE 40 30 333 A1 describes a locking device for laterally joined contactors whose actuating members for the movable contacts are electromagnetically moved in a direction substantially perpendicular to the connecting sidewalls. The two contactors are received in a common lower housing part. The actuating members of the two contactors have facing projections, which stand back from the connecting sidewalls and between which is supported a locking pin that is movable in a direction perpendicular to the connecting sidewalls, which are provided with openings at this location. When switching on one of the two contactors, the projection thereof moves the locking pin toward the other contactor. When attempting to switch on the other contactor, the projection thereof strikes the locking pin. The holding force of the electromagnetic operating mechanism of the already switched-on contactor is greater than the pickup force of the electromagnetic operating mechanism of the other contactor, which prevents the actuating member of the other contactor from moving to the ON position. It is a disadvantage of this locking device that, on the one hand, the actuating members are required to move in a direction perpendicular to the connecting sidewalls, and that the locking effect is no longer guaranteed when the electromagnetic operating mechanisms are operated with a holding power that is markedly reduced compared to the pickup power, which is what is generally being aimed at.

[0003] German Patent DE 195 48 480 C1 describes a locking device of this type which avoids the aforementioned disadvantages. The moving direction of the actuating members is perpendicular to the front face of the laterally joined contactors. A support element is inserted in opposite first slots in the connecting sidewalls, the support element supporting a locking element in the form of an anchor which is able to pivot in a direction perpendicular to the connecting sidewalls. The connecting sidewalls have opposite second slots for receiving the anchor. When energizing the electromagnetic operating mechanisms of both contactors

simultaneously, the anchor engages recesses of both actuating members and prevents both contactors from being switched on. The recesses are each bounded by a front inner surface, a central inner surface, and a rear inner surface, which extend parallel or perpendicular or at an angle to the front faces, respectively. When energizing the electromagnetic operating mechanism of one contactor alone, the anchor is moved out of the recess of the actuating member of this contactor and pushed into the recess of the actuating member of the other contactor, thereby effectively locking the same from being switched on. The two contactors are connected by connecting elements whose outer legs engage like brackets around ribs extending from the connecting sidewalls and whose central leg engages in a positively locking manner in a recess formed in the connecting sidewalls. In this locking device, two complicated parts are needed for the support element and the anchor, which involves high tooling costs. The existing locking stroke of the locked contactor requires exact matching of the geometries of the first slots, the support elements, the anchors, the recesses, and of the geometry, support and kinematics of the actuating members.

[0004] United States Patent US 4 409 575 A shows a mechanical interlock mechanism for mechanically connected contactors, including a locking element in the form of a rolling element, such as a cylindrical roller or a hollow cylindrical roller, which is supported in a connecting frame between the spaced apart contactors and is actuated by the contact frame of the respective contactor that is energized. The disadvantage here is the need for a connecting frame and the associated, relatively large spatial distance between the opposite sidewalls of the two contactors.

[0005] The object of the present invention is to facilitate the mutual locking of two contactors whose actuating members move in a direction parallel to the connecting sidewalls.

[0006] Starting from a locking device of the type mentioned at the outset, this objective is achieved according to the present invention by the characterizing features of the independent claims while advantageous refinements of the present invention will be apparent from the dependent claims.

[0007] The locking device of to the present invention simply requires only one additional part in the form of a rolling element, which cooperates with spherical cap-type recesses of the

actuating members as a connecting element. This type of locking results in a very small idle stroke for the contactor to be locked, which helps to increase reliability and allows the design engineer to calculate the play stroke in a simple manner. The electromagnetic operating mechanisms may be operated with a markedly reduced holding power.

[0008] The locking element may be implemented in an inexpensive manner using a purchased commercial part in the form of a ball, a cylindrical roller, a barrel-shaped roller, or a disk.

[0009] The auxiliary tool of the present invention facilitates the assembly of the locking device according to the present invention. A receiving space formed by the fork slot elastically holds the locking element at its opposite surface portions which are perpendicular to the connecting sidewalls and to the moving direction of the actuating members. Prior to fitting the locking device to a mounting rail or to another suitable mounting base, the two contactors must be brought together such that their connecting sidewalls are spaced apart by a distance that still allows the locking element held between the fork prongs to be moved by the auxiliary tool into the region of the openings in the connecting sidewalls. After moving the contactors closer together, the locking element extending beyond the flat sides of the auxiliary tool is trapped within the facing openings, allowing the auxiliary tool to be detached from the locking element and removed from the space between the connecting sidewalls. The locking device is completed by a final movement together of the contactors.

[0010] The reliability with which the locking element is held is increased by adapting the fork slot in the flat sides to the shape of the locking element to be held. Designing both ends of the auxiliary tool to hold a locking element serves the purpose of holding either a replacement locking element or, when suitably adapted, a differently shaped locking element at the second end.

[0011] Further details and advantages of the present invention will become apparent from the exemplary embodiments described below with reference to the Figures, in which:

[0012] Figure 1 shows the arrangement of two laterally joined lockable contactors;

[0013] Figure 2 depicts the inventive locking device as detail II from Figure 1;

[0014] Figure 3 shows an inventive auxiliary tool for making the locking device of the present invention in a perspective view (Figure 3a) and in a slightly enlarged sectional view through the center plane (Figure 3b).

[0015] In Figure 1, two mutually lockable contactors 2a and 2b are shown side-by-side. Contactors 2a, 2b are attached to a mounting base (not shown), such as a standard mounting rail. The right connecting sidewall 4a of contactor 2a, shown on the left, immediately adjoins the left connecting sidewall 4b of contactor 2b shown on the right. The two contactors 2a, 2b are joined together at opposite sides in a customary fashion and such that they are flush with each other, using bracket-like connecting elements 5, as is described, for example, in German Patent DE 195 48 480 C1. Thus, contactors 2a, 2b are no longer able to move away from one another.

[0016] Locking device 1 of contactors 2a, 2b will now be described in more detail with reference to Figure 2, which shows detail II from Figure 1. Connecting sidewalls 4a, 4b have two facing openings 6a and 6b, respectively. A portion of an actuating member 8a or 8b is located in the immediate vicinity of connecting sidewalls 4a, 4b, respectively. Actuating members 8a, 8b are operatively connected or coupled, on the one hand, to the electromagnetic operating mechanisms, and, on the other hand, to the movable contacts of contactors 2a and 2b, respectively. The moving direction of actuating members 8a, 8b is parallel to connecting sidewalls 4a, 4b and perpendicular to front faces 10a, 10b of contactors 2a and 2b. Actuating members 8a, 8b are provided with spherical cap-shaped recesses 12a or 12b in the vicinity of openings 6a, 6b. Recesses 12a, 12b are open to neighboring connecting sidewalls 4a and 4b, respectively. A locking element 14 in the form of a spherical rolling element made of metal, ceramic, plastic or glass-containing material rests within openings 6a, 6b. To the left and to the right, locking element 14 is held by adjacent portions of actuating members 8a, 8b and, for the rest, by the lateral boundaries of openings 6a, 6b.

[0017] When both contactors 2a and 2b are in the OFF state, the two actuating members 8a and 8b assume the upper position, which is depicted in Figure 2 for actuating member 8a shown on the left. In this situation, locking element 14 rests loosely between the two recesses 12a and 12b, which, in this instance, directly face each other through openings 6a and 6b. When, starting from this situation, one of the two contactors 2a or 2b is switched on, its

actuating member 8a or 8b may move unhindered from top to bottom, with respect to the view of Figure 2. In the case illustrated in Figure 2, contactor 2b located on the right has been switched on. As the associated actuating member 8b moves to the lower position by actuation stroke 16, locking element 14 is removed from the region of recess 12b and displaced through openings 6b and 6a to the left by the portion of this actuating member 12b that is not set back, and further into recess 12a of actuating member 8a of contactor 2a, which is shown on the left. Contactor 2a located on the left is thus locked from being switched on, because when attempting to switch on left contactor 2a as well, the blocked movement to the right of locking device 14 makes it impossible for actuating member 8a of left contactor 2a to move with its recess 12a out of engagement with locking device 14.

[0018] When the electromagnetic operating mechanisms of both contactors 2a and 2b are energized simultaneously, both actuating members 12a and 12b are prevented from moving downward, according to the view of Fig. 2, because the two spherical cap-shaped recesses 12a and 12b cannot simultaneously move out of engagement with locking device 14. When attempting to switch on contactors 2a and 2b simultaneously, they are held in the OFF state in conformity with regulations. Therefore, no race can occur between contactors 2a, 2b.

[0019] To facilitate insertion of locking element 14 between openings 6a, 6b, the fitter can use auxiliary tool 20 shown in Figure 3. Elongated auxiliary tool 20 is made of elastic material, preferably of plastic, and is designed at both ends 21 to receive the spherical locking element 14. For this purpose, ends 21 are split symmetrically into fork prongs 22. Receiving spaces 28 formed by elastic fork prongs 22 at both ends 21 can each hold one locking element 14 in a clamping fashion. For improved retention of locking elements 14, fork slots 30 are shaped in the form of spherical caps toward narrow sides 26 in the area of receiving spaces 28 to adapt them to the spherical shape of locking element 14. In the unloaded condition, it has proven advantageous for the fork slot opening width to be ¾ of the ball diameter of locking element 14, and for the facing inner surfaces of the spherical indentations in receiving spaces 28 to have a maximum distance of slightly less than the ball diameter. For example, for a ball diameter of 4 mm, the opening width is 3 mm and the maximum distance between the inner surfaces of the spherical indentations is 3.8 mm.

[0020] Locking element 14 is received in auxiliary tool 20 in such a way that part of its surface extends beyond flat sides 24. To insert locking element 14 into openings 6a, 6b, contactors 2a, 2b are initially brought to a distance at which locking element 14 still fits between the connecting sidewalls 4a, 4b. When flat sides 24 of auxiliary tool 20 face connecting sidewalls 4a, 4b, the auxiliary tool provided with locking element 14 may reach between contactors 2a, 2b and bring locking element 14 into the region of openings 6a, 6b. When contactors 2a, 2b are now moved closer together, locking element 14 is held by openings 6a, 6b and moved out of engagement with fork prongs 22 when auxiliary tool 20 is being withdrawn. Then, contactors 2a, 2b may finally be moved together such that they are flush with each other, and be joined by connecting elements 5, after which locking device 1 is complete.

[0021] The present invention is not limited to the specific embodiments described above but includes also all equally acting embodiments along the lines of the present invention. Thus, the locking device 1 may also be implemented using a locking element in the form of, for example, a cylindrical roller, a barrel-shaped roller, a circular disk, or an elongated disk. Recesses 12a, 12b on actuating members 8a, 8b and the shape of fork slots 30 in the flat sides of auxiliary tool 20 have to be adapted to the shape of the locking element accordingly.